Universitat Autònoma de Barcelona

2023/2024

Mathematical Statistics

Code: 106081
ECTS Credits: 6

Degree	Type	Year	Semester
2500149 Mathematics	OT	4	1

Contact

Name: Ana Alejandra Cabaña Nigro

Email: anaalejandra.cabana@uab.cat

Teaching groups languages

You can check it through this link. To consult the language you will need to enter the CODE of the subject.
Please note that this information is provisional until 30 November 2023.

Prerequisites

The competencies in algebra, analysis and probability and statistics of the first cycle of mathematics are assumed.

Objectives and Contextualisation

The general objectives of this course in mathematical statistics, are:

1. Understanding the theoretical foundations of empirical processes and their limits.
2. Explore goodness-of-fit techniques to assess the adequacy of a statistical model to observed data.
3. Study the bootstrap method as a tool for statistical inference and estimating the distribution of an estimator.
4. Analyze extreme value theory and its application in modeling rare and extreme events.
5. Develop practical skills in implementing statistical methods related to the aforementioned topics.
6. Apply the acquired knowledge in solving real-world problems and interpreting statistical results appropriately.
7. Foster critical thinking and analytical ability to evaluate and question assumptions and findings in statistical analysis.
8. Promote effective communication of statistical concepts and obtained results through technical reports and presentations.

These general objectives will help students acquire a solid understanding of fundamental concepts and techniques in mathematical statistics and apply them effectively in problem-solving related to empirical processes, goodness of fit, bootstrap, and extreme value theory.

Competences

- Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
- Effectively use bibliographies and electronic resources to obtain information.
- Generate innovative and competitive proposals for research and professional activities.
- Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
- Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
- Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
- Understand and use mathematical language.

Learning Outcomes

1. Actively demonstrate high concern for quality when defending or presenting the conclusions of one's work.
2. Effectively use bibliographies and electronic resources to obtain information.
3. Generate innovative and competitive proposals for research and professional activities.
4. Students must be capable of communicating information, ideas, problems and solutions to both specialised and non-specialised audiences.
5. Students must develop the necessary learning skills to undertake further training with a high degree of autonomy.
6. Students must have and understand knowledge of an area of study built on the basis of general secondary education, and while it relies on some advanced textbooks it also includes some aspects coming from the forefront of its field of study.
7. Understand abstract language and understand in-depth demonstrations of some advanced theorems of probability and statistics.

Content

1. Nonparametric sratistics and empirical processes.
2. Bootstrap.
3. Extreme value theory.

Methodology

The statistical models and their corresponding assumptions and properties are introduced in the theoretical sessions. Emphasis will be placed on rigor in the proofs as well as on the applicability and interpretation of the methods.

The discussion will be encouraged in the classroom and theoretical problems will be proposed to deepen the topics. Problems, and practical exercises to be performed with free software R will be proposed.

Some sections of the course could be developed by students in the form a written report and presented to the classmates.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Computer work	24	0.96	1, 3, 4, 2
Problems sessions	6	0.24	7, 4, 2
Theoretical classes	30	1.2	7, 2
Type: Autonomous			
Personal work	80	3.2	3, 4, 2

Assessment

NC = 0.25*P1 + 0.25*P2 + 0.25*P3 +0.25*Lli,

P1, P2, and P3: First and second partial exams, including theory, exercises, and practical component.

Lli: Grade for the proposed task submissions: solving theoretical and practical problems, and/or grade for autonomous work in which collateral topics or theory extensions will be developed and presented in written and oral form.

Students who do not pass the continuous evaluation, that is, if NC<5 or P_i<3, can take the 75% recovery exam corresponding to P1 + P2 + P3.

The single evaluation will consist of a comprehensive exam covering the 3 topics addressed in the course, including a computer-based part and an oral component.

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First partial exam	0,2	4	0.16	7, 4, 2
Oral exposition of a report	0,2	1	0.04	1, 3, 6, 5, 4, 2
Second partial exam	0,3	4	0.16	1, 4, 2
Tasks delivery	0,3	1	0.04	3, 4, 2

Bibliography

Nonparametric Statistics:

1. Hollander, M., & Wolfe, D. A. (1999). Nonparametric Statistical Methods. Wiley.

2. Tsybakov, A. B. (2009). Introduction to Nonparametric Estimation. Springer.

3. Gibbons, J. D., & Chakraborti, S. (2010). Nonparametric Statistical Inference. CRC Press.

Empirical Processes:
1. "Empirical Processes: Theory and Applications" by Richard D. Pollard
2. "Weak Convergence and Empirical Processes: With Applications to Statistics" by Aad van der Vaart and Jon A. Wellner
3. "Empirical Processes in M-Estimation" by Vladimir Spokoiny

Extreme Value Theory:
1. "Extreme Value Theory: An Introduction" by Laurens de Haan and Ana Ferreira
2. "An Introduction to Statistical Modeling of Extreme Values" by Stuart Coles
3. "Extreme Value Theory: An Introduction" by F.G. Bosman, C.A.J. Klaassen, and A.J. Haan

Bootstrap:
1. "An Introduction to the Bootstrap" by Bradley Efron and Robert J. Tibshirani
2. "Bootstrap Methods and their Application" by A.C. Davison and D.V. Hinkley
3. "Bootstrap Techniques for Signal Processing" by Martin R. Cramer, Janice R. Eichenberger, and R. E. Hiorns

These books provide comprehensive coverage of their respective topics and are widely recognized as valuable resources in the field.

Software

Free software R and Rstudio.